



RESEARCH DEPARTMENT

Some statistical parameters of the quasi-peak voltage of BBC sound programmes

RESEARCH REPORT No. L-064

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Appendix

The last two figures in the last column of the table in the Appendix, corresponding to Fig. 10(b) and Fig. 10(c) respectively, are incorrect and should be amended as follows:-

For -7.6 dB read -8.8 dB

For -8.6 dB read -7.6 dB

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BBC SOUND PROGRAMMES**

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SOME STATISTICAL PARAMETERS OF THE QUASI-PEAK VOLTAGE OF BBC SOUND PROGRAMMES

SUMMARY

The frequency of occurrence of peaks in the programme signal level, as registered by a peak programme meter circuit, has been measured and the results presented in the form of cumulative statistical distribution curves. Separate data for various types of programme are given together with data for all programmes averaged over a number of days.

1. INTRODUCTION

For the efficient design and operation of a sound reproducing system, it is necessary to take into account moment-to-moment fluctuations in the crest value of the electrical signal to be transmitted or recorded. To obtain information on this subject, the statistical distribution of the quasi-peak levels as read on a standard BBC programme meter has been determined for various types of broadcast programme material.

It should be noted that the programme material analysed was not derived directly from the output of a microphone, but from the output of a studio, so that the original fluctuations in level will in general have been modified by the intervention of the control operator, but no form of electronic compression or limiting had been applied to the material except where this is specifically mentioned.

2. EXPERIMENTAL DETAILS

All the data reported have been obtained from a peak counting mechanism¹ which registers and sums the number of signal peaks that exceed five pre-selected reference voltages, chosen to suit the programmes concerned. The mechanism is actuated by the current flowing in the meter circuit of a peak programme meter amplifier type PPM/2 and is designed to register a peak whenever this current passes through a maximum followed by a fall in value corresponding to 3 dB or more on the meter scale. This arrangement is almost immune to surface noise on worn commercial disk records and it also reduces the peak counting rate to well within the capacity of the mechanical integrators used; the rate is usually near 35/min and it rarely exceeds 50/min.

When the material is available as a recording it is possible to obtain very precise data by replaying it successively at different levels; in this way, the reference voltages can be made to fall in any part of the dynamic range of the recording, so that detail is measurable even in the weakest passages. With live programme, however, this procedure is not possible, and the reference voltages have to be selected to give the best compromise.

In the analysis of live programmes, the equipment was arranged to operate from 6.45 a.m. until midnight every day. Counter readings were automatically photographed and re-set to zero every 15 minutes; later the data on the photographs were read off and tabulated. Readings of individual counters rarely exceeded 500.

3. RESULTS

The cumulative frequency distributions for the various types of programme material investigated were initially plotted in the form of sigmoid curves to a linear ordinate scale; to facilitate comparison, the data, normalized, was later transferred to Gaussian probability paper, as shown in Figs. 1 to 10. The points on the curves show the reference levels at which the peak counters were set.* To avoid errors in reading from the curves, the percentage values corresponding to a series of abscissae at 2 dB intervals have been tabulated (see Appendix). The zero level for the decibel scale represents the nominal maximum signal level; the proportion of peaks which in practice exceed this value is usually in the region of 1%. In specifying the dynamic range of a programme, however, it is convenient to

* In the case of Fig. 1, derived from recordings analysed by repeated replaying as described in Section 2, the number of points is greater than the number of counters.

consider a more frequently occurring condition and to refer to the level which is exceeded by 2% of the peaks. The corresponding lower limit is then taken as that level which is exceeded by all but 2% of the peaks; the difference between the two figures is referred to as the "2% to 2% range" and is shown in the Appendix.

Figs. 1(a) and 1(b) refer to recorded material and the remainder to live programme; in the latter case, most of the information was derived from a total of nearly 500,000 data obtained on the Light Programme from 15.7.61 to 24.7.61, and on the Home Programme from 28.8.61 to 5.9.61. Most of the programme classifications used in the figures and table are self-explanatory; it should be noted, however, that the term "didactic speech" has been used to cover items such as news readings, which have the minimum of dramatic content, "commentaries" to include talks and comments on the news, and "Musical Ensemble" to cover solo singers and instruments.

Figs. 1(a) and 1(b) are derived from short excerpts of didactic and dramatic speech respectively. Figs. 2(a) and 2(b) show respectively the distribution for one half-hour programme of light music and one complete symphony. Fig. 3 relates to a radio play and Fig. 4 to a Promenade Concert; in each case, separate curves are given for different parts of the performance.

In contrast to Figs. 1 to 4, which refer to particular cases, Figs. 5 to 8 show a series of curves each derived from all the data on one class of programme. It should be noted that because of the rare occurrence of poetry and opera in the programmes, the time available for the analysis of such items was short and the form of the distribution shown may not be fully representative of its kind. With this reservation, the curves of Figs. 5 to 8 may be regarded as prototypes for the various classes of material.

Fig. 8(b) shows the distribution for popular music programmes; these are a mixture of live and commercially recorded material, the dynamic range of the latter being generally compressed electronically.

Each of the Figs. 9(a) to 9(e) represents the distribution for a complete day's programme in the Home Service while Figs. 10(a) and 10(b) show corresponding data for the Home and Light Programmes respectively, each averaged over about 140 hours; it should be noted that the Light Programme carries no poetry or opera. It will be seen

that the 2% to 2% ranges of the Light and Home programmes are both between 15 and 16 dB.

Fig. 10(c) is based on the sum of all the data registered in the course of the investigation; it must be pointed out that this data contains no contribution from the Third Network or the Overseas Service. It will be noted that the median value of the overall data is 1.8 dB higher in the Home programme than in the Light. Not more than 1 dB of this could be accounted for by errors in line-up between Broadcasting House and Kingswood Warren.

Speech in foreign languages is of interest because a significant proportion of Overseas broadcasting involves programmes of this kind. It was at first supposed that foreign speech would have stress-patterns so different from English that the statistical distribution would not be of the same form, but after analysing some twenty-five foreign speech recordings - ranging from Chinese to French - no major peculiarities were found, and it can safely be assumed that the prototype distributions given for English speech are applicable. Thus a fairly representative distribution for an Overseas programme could be forecast by summing, in due proportion to their contribution to the programme, the prototype curves already illustrated.

It was found that the dynamic range of foreign speech, particularly of announcements by women, was smaller than in English, although foreign male speech also had a smaller range. It may be that this implies more careful speech training of the foreign announcer, or more careful selection. Thus, contrary to popular conception, it appears that foreigners impart less rather than more "drama" to essentially undramatic broadcast statements than their English counterparts.

It should be noted that the data on foreign language programmes referred to above relates to the signal leaving the studio and does not take into account the effect of the automatic gain control devices used at transmitters in the Overseas Service to reduce the dynamic range of the programme.

4. CONCLUSIONS

Most of the data presented here were obtained some years ago, so that curves such as those of Fig. 8(b) may be outdated by subsequent changes in programme content or, in the case of "pops", by the increasing degree of electronic compression employed. On the other hand, the form of the statistical distribution is controlled by factors common to all speech and all music and because of this it is safe to predict that any repetition of the present

experiment would yield, if not a precise copy, a tolerable imitation of the individual prototype curves given here.

The data presented in this report have already been put to practical use in predicting the subjective distortion produced by a transmitter² under various conditions of operation and are being used as a guide to the development of automatic gain control devices in general.

5. REFERENCES

1. Peak counting and integrating circuits for the statistical analysis of programme levels. Research Department Technical Memorandum No. L-1004, 1950.
2. The application of limiters for m.f. amplitude-modulated transmitters in the domestic services. Research Department Technical Memorandum No. L-1013, 1963.

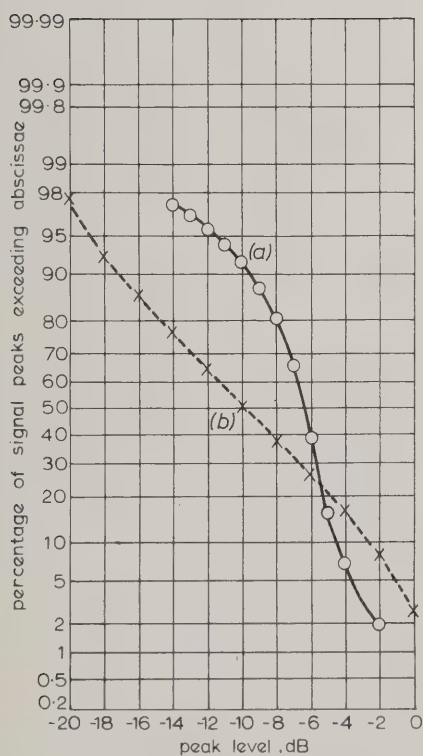


Fig. 1

- (a) News Reading (1.92 mins.)
 (b) Speech from "Back to Methuselah" Dame Edith Evans (2.75 mins.)

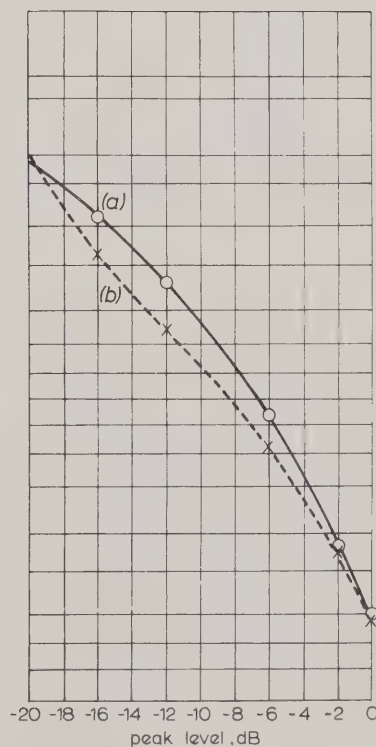


Fig. 2

- (a) Music while you work (28 mins.)
 (b) 5th Symphony. Vaughan Williams (34 mins.)

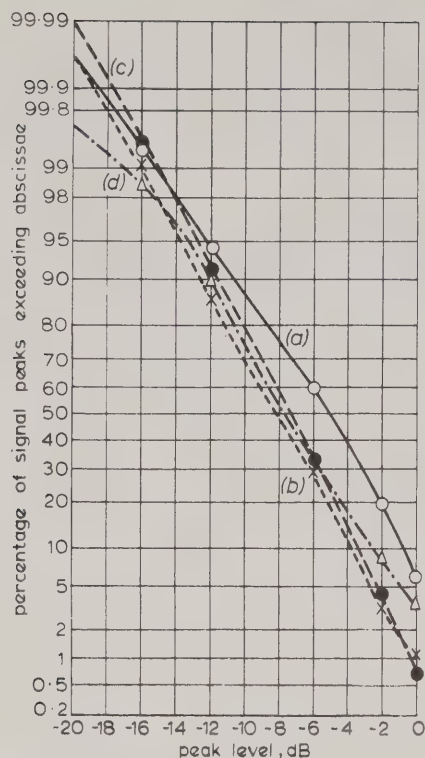


Fig. 3 - Saturday night theatre (2.9.61)
 (a) First half hour (b) Second half hour
 (c) Third half hour (d) Complete play (1.5 hours)

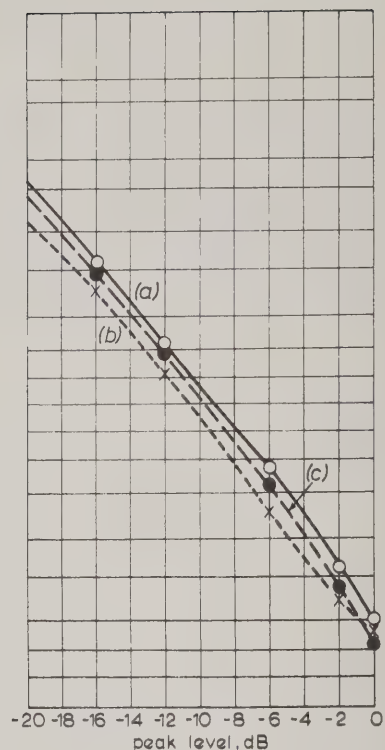


Fig. 4 - Promenade concert (1.9.61)
 (a) First half (b) Second half
 (c) Complete concert (2 hours)

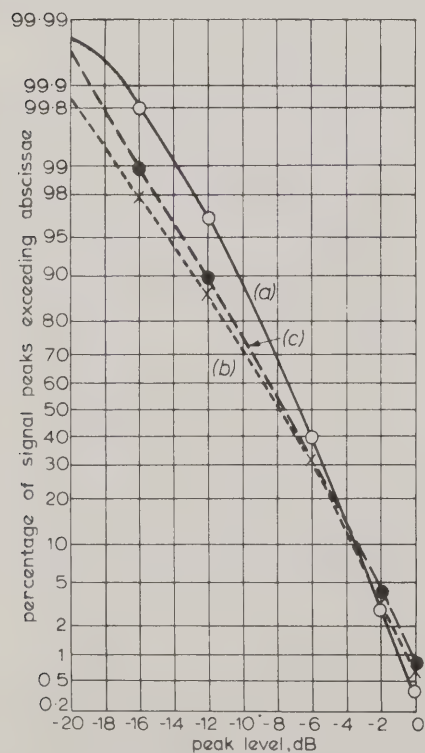


Fig. 5 - Speech other than dramatic
 (a) Didactic speech (17.5 hours)
 (b) Commentaries (28.0 hours)
 (c) Discussions (31.5 hours)

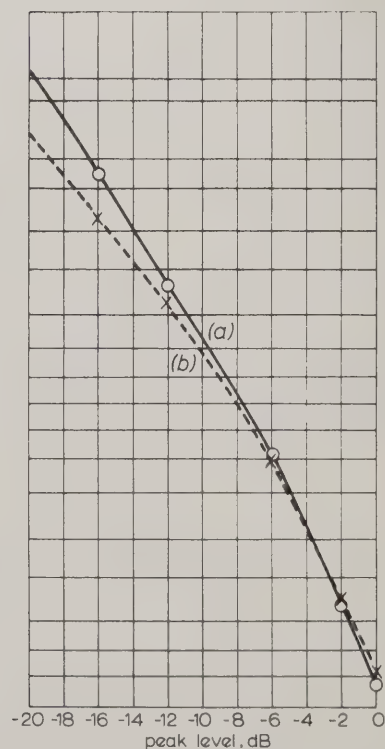


Fig. 6 - Dramatic speech
 (a) Poetry (2.5 hours) (b) Plays (23.25 hours)

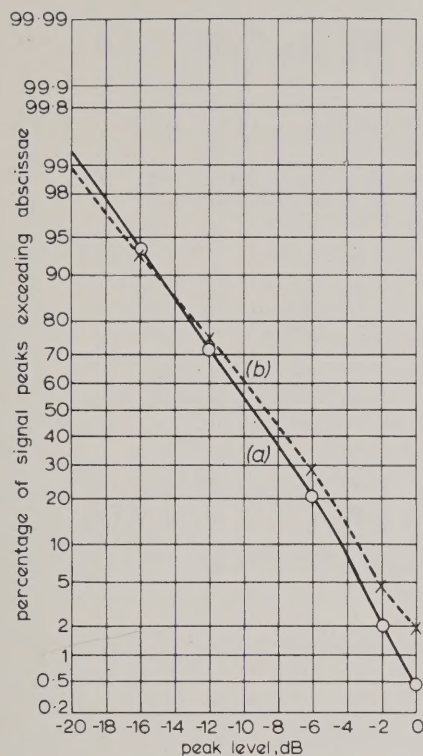


Fig. 7 - Dramatic music
(a) Opera (4.75 hours)
(b) Symphonic music (21.75 hours)

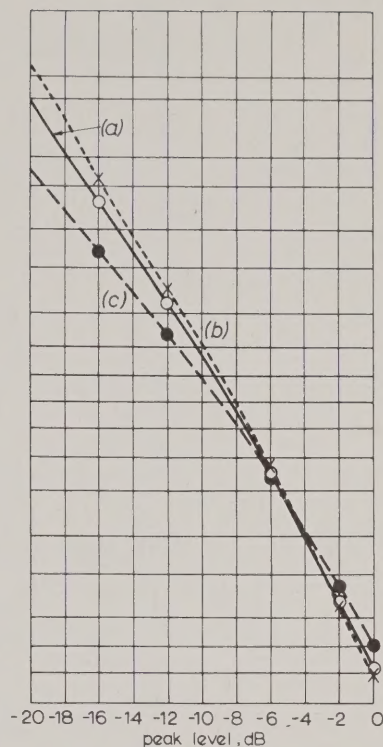


Fig. 8 - Light music
(a) Review etc. (84.25 hours)
(b) Jazz and "Pops" (38.0 hours)
(c) Ensemble (27.25 hours)

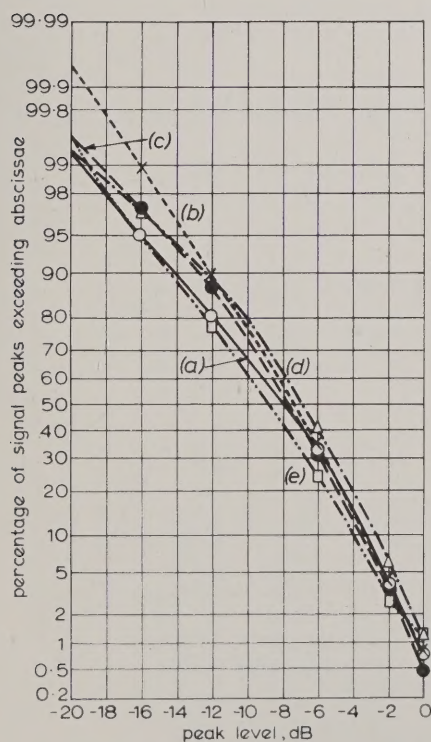


Fig. 9 - Day summations. Home service, for five separate days
(a) August 29th 1961 (b) August 31st 1961
(c) September 1st 1961 (d) September 2nd 1961
(e) September 5th 1961

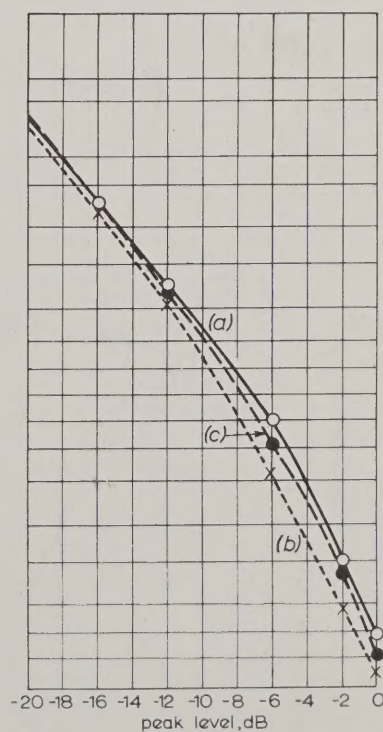


Fig. 10 - Summations of all data for 10 days of light programme and home service
(a) Home service (140.25 hours)
(b) Light programme (138.5 hours)
(c) All light and home (278.75 hours)

APPENDIX

FIGURE NO.	DESCRIPTION	DURATION	-20dB	-18dB	-16dB	-14dB	-12dB	-10dB	-8dB	-6dB	-4dB	0dB	2% TO 2% RANGE	MEDIAN
														dB
	PERCENTAGE OF SIGNAL PEAKS EXCEEDING LEVELS SHOWN ABOVE													
Fig. 1(a)	News	1-92 mins.	97.9	93.1	86.4	97.5	95.5	92.0	80.5	39.0	7.2	2.0	13.0	-6.3
(b)	Dramatic Speech	2-75 mins.				77.4	65.9	51.4	38.7	26.1	16.5	8.0	20.5	-9.8
Fig. 2(a)	Music While You Work	28-00 mins.	98.8	97.7	95.7	92.0	87.0	78.8	65.2	45.2	21.5	8.3	18.4	-6.5
(b)	Symphony	34-00 mins.	99.0	96.8	92.0	85.0	75.0	62.2	47.5	32.5	18.2	7.4	18.8	-8.4
Fig. 3(a)	First Half Hour	30-00 mins	99.97	99.85	99.4	98.0	94.5	87.8	76.0	61.0	39.7	20.0	15.0	-5.1
(b)	Second Half Hour	30-00 mins.	99.97	99.8	99.1	95.7	86.5	71.0	50.5	29.0	12.0	3.5	1.1	-8.0
(c)	Third Half Hour	30-00 mins.	99.99	99.93	99.5	97.3	91.0	77.0	55.0	32.0	14.5	5.0	0.7	-7.6
(d)	Complete Play	90-00 mins.	99.7	99.3	98.5	96.2	90.0	74.5	52.0	32.0	16.5	8.5	3.3	-7.6
Fig. 4(a)	Promenade	-	98.3	95.7	91.0	83.5	72.0	57.8	42.0	27.5	15.0	6.0	2.1	-9.2
(b)	Concert	-	96.0	91.7	86.0	76.5	62.0	45.5	28.4	15.5	7.5	3.2	1.5	-10.6
(c)	Complete Concert	2 hours	97.6	94.5	89.0	80.6	68.8	53.5	37.0	22.0	10.3	4.0	1.1	-9.6
PROTOTYPES														
Fig. 5(a)	Didactic Speech	17.5 hours	99.98	99.96	99.8	99.2	96.5	88.0	68.0	39.0	14.3	2.8	0.35	-6.8
(b)	Commentaries	28.0 hours	99.86	99.42	97.9	94.3	86.5	72.9	53.0	31.0	12.8	3.2	0.7	-7.8
(c)	Discussions	31.5 hours	99.97	99.8	98.9	96.4	89.5	76.2	55.0	31.6	13.7	4.0	0.73	-7.6
Fig. 6(a)	Poetry	2.5 hours	99.93	99.65	98.5	95.1	87.3	73.5	54.0	31.0	11.8	2.8	0.4	-7.6
(b)	Dramatic Speech	23-25 hours	99.52	98.56	96.0	91.9	83.5	69.5	49.4	29.6	11.8	3.2	0.55	-8.1
Fig. 7(a)	Opera	4-75 hours	99.35	97.7	93.5	85.5	72.0	55.0	36.5	21.0	8.0	2.0	0.45	-9.4
(b)	Symphonic Music	21-75 hours	98.9	97.1	93.0	85.8	75.0	60.2	44.8	28.7	14.00	4.7	1.9	-8.6
Fig. 8(a)	Review	84-25 hours	99.8	99.1	97.0	92.5	82.5	66.5	46.0	24.6	9.0	2.7	0.5	-8.4
(b)	Jazz and "Pops"	38-00 hours	99.93	99.65	98.3	94.7	86.0	71.0	50.0	27.0	10.3	2.6	0.42	-8.0
(c)	Musical Ensemble	27-25 hours	98.6	96.4	92.0	84.5	72.6	58.3	40.7	23.8	10.8	3.5	0.9	-9.0
Fig. 9(a)	Aug. 29 1961	{ Approx. 17 hours each	99.25	97.9	95.0	89.6	80.6	67.9	50.5	31.6	14.9	3.7	0.7	-7.9
(b)	Aug. 31 1961		99.95	99.74	98.95	96.2	89.5	77.0	58.0	35.0	15.3	4.1	0.65	-7.3
(c)	Sept. 1 1961		99.53	98.8	97.0	94.0	87.9	73.9	54.0	31.0	13.0	3.6	0.45	-7.7
(d)	Sept. 2 1961		99.32	98.5	97.0	94.2	89.0	79.0	62.0	40.4	19.5	6.0	1.1	-6.8
(e)	Sept. 5 1961		99.5	98.0	95.0	88.7	78.0	63.0	44.0	25.0	10.0	2.9	0.6	-8.8
Fig. 10(a)	Summation of Home programmes	{ 10 days	99.67	98.92	97.0	93.2	86.0	74.8	59.2	39.0	18.2	4.7	1.0	-7.0
(b)	Summation of Light programmes		99.6	98.6	96.3	91.5	81.4	65.2	43.5	21.1	7.3	1.7	0.3	-7.6
(c)	Summation of Home and Light Programmes		99.7	99.0	96.9	92.5	84.0	71.0	53.5	31.0	13.0	3.8	0.55	-8.6

